Composite Redesign of Obstetrical Forceps

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The goal of this technology development project is to design, test, and manufacture a set of obstetrical forceps using state-of-the-art instrumentation technology and fiber-reinforced polymer materials. A fiber-optic strain sensor will be embedded into a specific position of the polymer during fabrication to enable the physician to read the amount of compression and tensile load being applied to an infant's head during delivery. A tailored thickness portion of the forceps will utilize the elasticity of the polymer material and provide a fail-safe method to prevent the physician from placing an unsafe amount of force on an infant's head under normal delivery conditions. The major objective of this work is to develop a set of instrumented forceps to be used to perform clinical trial studies.

On March 5, 1993, NASA/MSFC received a problem statement from Dr. Jason Collins of the Collins Clinic identifying a need for improving the function of obstetrical forceps. The request was for assistance in redesigning the current stainless-steel Simpson-type forceps, so as to reduce the risk of injury to infants and mothers during a forceps-type delivery, while at the same time keeping as much of the traditional appearance and functionality of the forceps as possible.

The forces induced onto the fetal head during a forceps delivery are primarily the traction or pull force (tensile) and the compressive force needed to overcome the friction or resistance of the maternal tissues. According to previous studies by Fleming, Pearse, Wylie, and Ullery, the major factors that influence the performance of forceps are: (1) the structure of the instrument; (2) the fetal head that the forceps must grasp; (3) the resistance of the maternal tissues; and (4) the force applied by the attendant. Studies of the amount of pull force and compressive force applied to infants during delivery have been limited. Strain gauges for measuring total force and calibrated instruments like the axis-tractionometer for measuring traction have been used with limited success to gain useful data with respect to measuring those forces imposed on the infant by the use of the forceps for delivery. Although no limits have been established, measurements from these field tests do give valuable data for this redesign effort.

The redesign of the obstetrical forceps will begin with coupon testing of candidate thermoplastic materials embedded with fiber-optic gauging at MSFC. After the characteristics of the material and sensor sensitivity have been determined, a final design of the forceps will be completed. The Collins Clinic will provide the manufacturing expertise to produce a prototype set of forceps for MSFC characterization. Once the technology has been proven in the laboratory, clinical studies at the Pregnancy Institute will take place. A patent application has been completed and filed with the Chief Council's Office detailing this technology development.

This project is an excellent application of NASA reinvestment into the community. Once proven, the technology will provide a safer delivery process for both mother and baby.

Ullery, J.C.; Teteris, N.J.; Botschner, A.W.; and McDaniels, B. 1963. Traction and Compression Forces Exerted by Obstetric Forceps and Their Effect on Fetal Heart Rate. Columbia, Ohio.

Morey, W.W., Jr.; Dunphy; and Meltz, G. 1991. Multiplexing Fiber Bragg Grating Sensors. United Technologies Research Center, East Hartford, Connecticut.

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Sponsor: Technology Utilization Office (Space Act Agreement)

Industry Involvement: Collins Clinic, Fiber and Sensor Technology